From Skin to Scale: Sensing Student Haptic Abilities (A Case Study on Clinical Breast Exams)[1] (2019)

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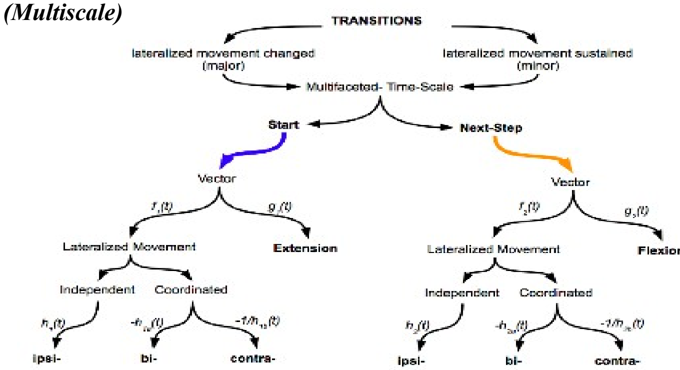
Extended Abstract

Already, radar detection traces path-finding via an excitable boundary system. How to translate biological boundaries into next-generation physical computing an *excitable registration*? In a *direct biological interface* wearability records in real-time behavioral process under the skin excitable membranes (boundary systems). A technology with direct biological interface is overdue to counteract observations of sensorimotor behaviors in a black-box. Accuracy in movement recordings will index *preconditions* or *prerequisite* premotor cortical potentials (Dirnberger *et al.,*1998). This behavioral research attempts to authenticate the translation of motor circuits' neuroplasticity within a multiscale computational infrastructure to *minimize* biological uncertainty and *maximize* behavioral assessments. A clinical breast exam serves as a robust testbed to reconcile multiscale computation according to: (1) granular indexing of behavioral resolution in posture shifts; (2) motor circuits (inhibitory, excitatory); and, (3) expert exercise of anatomical knowledge. **Background.** This case study compares three capture strategies: (1) Pugh's sensor training system (Kotranza *et al.*2009); (2) multi-tool radiological practice (Kolb *et al.,* 2002); and, (3) proprioception model (Khoshhal *et al.*, 2010). The diagnostic screening by medical students' haptic abilities transfers biological criteria across movement analysis. The clinician's movement and knowledge replaces spatial locomotion with three motion indicators. *Assessment-Problem*: exploratory sensorimotor behavior and anatomical knowledge in a clinical exam. *Search-Problem*: differential screening, each breast with varying density and lesions. *Classifier-Proble*m: assessing each medical student's haptic ability using anatomical knowledge with a personalized signature (temporal and sensorimotor). At the crossroad of *big-simulations*: (1) large scale cortical studies (*in silico*); (2) nanoscience co-cultures (stem cell & microfluidics) or species preparations (*in vitro*); or, (3) the physicality of pervasive computing a *translational practice* revisits movement as *biologically principled inputs allocated through behavioral outcomes*. Translational methodology informs interdisciplinary studies as a specialization in "*what we see.*" **A Translationally Principled Computational Infrastructure.** Why build a motion capture on existing computational hierarchy? "Precise knowledge of computations performed by brain circuits is not crucial for the construction of clinically relevant BMIs" (Lebedev & Nicolelis, 2006). A research agenda grounded on translational criteria (from *skin* to *scale*) builds appliances from the ground-up by positing a: material platform, conceptual organization, and physical computing for the transformation of existing tools into a novel *behavioral computational infrastructure*. Since Edward Muybridge's (1830-1904) photographic study on the question: "If all feet leave the ground during a horse's gallop?" motion assessment remains: (1) *biologically neutral* (a spatial measure based on cinematic recordings with frame-by-frame expressions); (2) *anatomically skewed* without the first-person perspective (over the shoulder) of proprioception; and, (3) *kinematics computation* without state variables of neuroplasticity Kelso's (2012) multistability. Image-based motion capture makes no distinction between the movement of a rock and biological motion. The multiscale capture of biologically principled inputs investigates levels of neurophysiology hidden from image-based capture. This translational research agenda inquires into several topics: (1) pattern for a diagnostic assessment; (2) behavioral resolution series and electrophysiological routines in biometric sensing; and, (3) a wearable paradigm as *tool-use orients to any biological movement*. **From Prosthesis to Physiome.** Posture shifts act as a transparent medium which tag in 360° from *skin to scale* to approximate Arber's (2012) *interleaving organization of motor function.* A wearable system monitors the *transparency* and *self-measurement* disclosed by a *physiome* (sensorimotor switching, skin innervation, and neuroplasticity). Adjustments *in movement expressed as transitional pairs {(from-, evacuation)|(to-, entry)} index under the skin state variables* (electrophysiology, sequential patterns, and excitatory/inhibitory exchanges). RFID sensors compute from skin to scale according to translational observations. A wearable appliance marks difference to capture configurations of central pattern generator activity (Marder & Calabrese, 1996) in routine behaviors. Since Chalfie *et al.* (1985) backward posture shift's wiring vary from forward movement's wiring unlike cinematic rewind. A direct biological interface reconciles a material configuration (RFID tags) with a kinematic model (free-body-diagram): local dynamics of a wind chime model biological movement as local interactive histories (genidentic Reichenbach *et al.,* 1957) with physical operators (insertion, superimposition, and juxtaposition) supersedes the utility of cinematic recordings. Systematic indexing of combinations of motor behaviors and skin innervation transforms visual evidence. Deleuze's (1994) *intensities of difference* ($E \rightarrow e$, $e \rightarrow \varepsilon$, $\varepsilon \rightarrow \varepsilon'$) organize multi-scale indexing. Anatomical behavioral descriptions of interlimb movement (Bobbitt, 2015) support a novel visual index: a granular drilling into posture shifts. **Excitable Registration.** Where does data come from? A direct computation during posture shifts follows physical operators and posture detection rules across local neighborhoods. A skin to scale wearable reads switching and regulation in biological movement in a translationally principled recording system. From skin to scale extends Galvani's 1791 studies (Galvani *et al.*, 1953) and electrophysiology (Hodgkin & Huxley, 1952) as a behavior circuit (Bobbitt, 2016b) transmits a musculoskeletal motion capture. A real-time processing of posture shifts warrants an excitable interface (behavioral circuit): (1) RFID data (posture shifts); (2) simulated electrophysiological data extracted from NEURON (Hines & Carnevale, 1997); and (3) mathematical expectation based upon multifunctional circuits (Briggman & Kristan, 2008). A wearable's multiscale computation (Wenian & Engquist, 2003) translates tissue engineering's 3-way organization (extracellular platform, cellular, and molecular processing). The body moves (fills-in) are registered/processed by a smart garment.

[1] A novel wearable movement recording system addresses the challenge proposed in 2009 by the Interagency Modeling and Analysis Group (NIBIB): *"Models that generate testable hypotheses regarding the biological underpinnings of behavioral and social phenomena and processes at the individual and population level."*

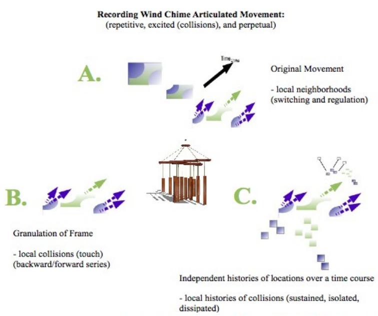
Building Behavioral Computational Infrastructure (Multiscale)

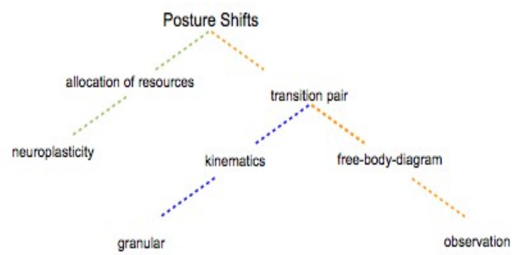
Intensity (E-E')	*Behavior Markers (High Behavioral Resolution)*	*Time Markers (Behavioral Plasticity)*
E refers to... e – e'	*laterality* → (ipsi-, bi-, contra-) >	*transition* → t(from-, to-)>
	musculoskeletal → extension | flexion >	*repetition* → serial, cyclic>
	interlimb activity → independence | coordination >	*switching rate* → *en route*>
	geography touch fields → dorsal | ventral.	*perpetuation* →local time.
e refers to... ε – ε'	{(*ipsi-, bi-, contra-*)} → {(from- | to-)	*t(from-, to-)* → fractional series
	{*extension* | *flexion* } → sensorimotor transfer	*serial, cyclic* → excited | inhibit
	independence | coordination → backward |forward	*en route* → multi-function
	{ *dorsal* | *ventral* } → geography touch receptors	*local time* → flow patterns

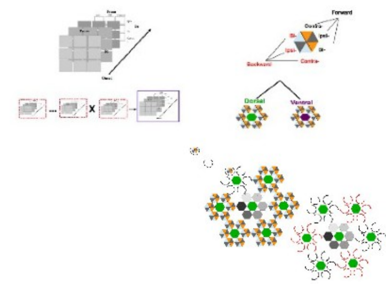


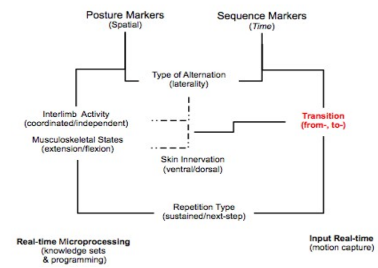
Local Positioning System

1. Local (free-body-diagram) → 2. Unconventional Geometry → 3. Porous Solid Fractal Bio-Encoding (Back/Forward Movement) → 4. Behavioral Circuit





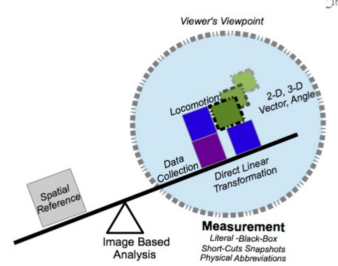


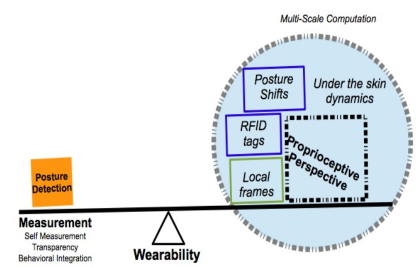


2 Examples of the First Person Perspective

Left Split screen illustrates the first person perspective (over the shoulder) in cinema from De Palma's movie Sisters (1973).

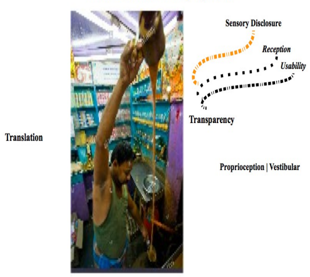
Right autism scene-only scanning black lines in (a) & (b) typically developed viewer social-scanning white lines in (a) & (b).from Klin *et al.* (2003)





HOW TO TRANSLATE PHOTOGRAPHY INTO THE FIRST PERSON PERSPECTIVE

Photo abbreviates sensory experience



First person perspective diagrams sensorimotor

engagement

while your body manipulates objects.

Wearable Diagram Records:

(1) sensory feedback elevated hand;

(2) manual grasp;

(3) joints' articulated control;

(4) equilibrium or proprioception.

Any photo of long pull tea pouring abbreviates sensory experience.

Removing the black-box & wearables recognizes sensory controls:

Graphics for Hidden Values (sensorimotor)

Proprioception | Vestibular

Musculoskeletal | Sensory Feedback

BODY FILLS A GARMENT WHILE RECORDING POSTURE SHIFTS

Diagramming the first person perspective aligns:

(1) **overhead sensory feedback**

(weight-bearing) tea pours (pot → cup);

(2) **lower equilibrium maintained** as the tea pour grasps a cup;

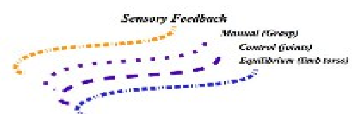
(3) **draws bio-mechanical patterns** (lateral, extension/flexion, etc.)

Wearable interface measures:

(1) **prerequisite conditions** (cellular mechanisms)

(2) **preliminary posture settings** (posture shifts as transitions pairs: (from-, evacuation)| (to-, entry)

(3) **traces** of past, present, and condition for the next steps



Markers | Cues & Hidden Variables

(Translational & Visual Formalisms)

Prerequisite Conditions &

Preliminary Posture Settings

Removing the blackbox | ← **Sensory Controls (Musculoskeletal | Sensory Feedback)**

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